

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization International Bureau



(43) International Publication Date
31 March 2005 (31.03.2005)

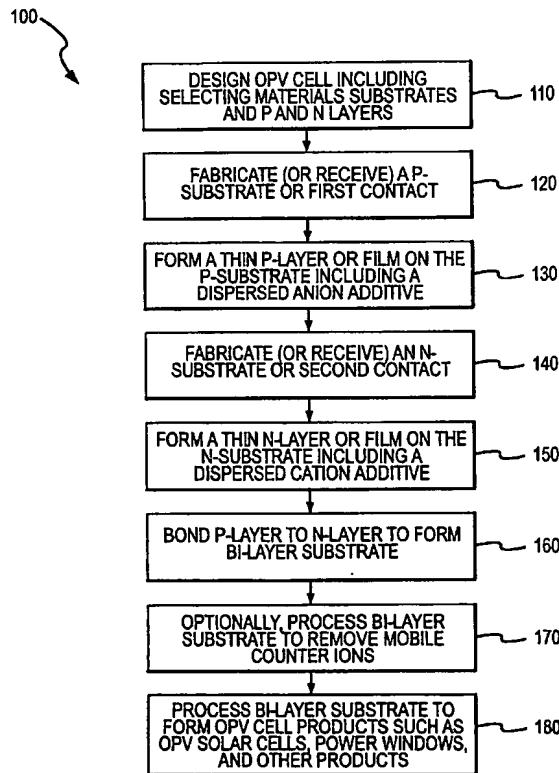
PCT

(10) International Publication Number
WO 2005/029592 A1

- (51) International Patent Classification⁷: H01L 31/04, 31/0256, 31/0352, 31/0384, 31/18
- (72) Inventor; and
(75) Inventor/Applicant (for US only): GREGG, Brian, A. [US/US]; 13940 Braun Drive, Golden, CO 80401 (US).
- (21) International Application Number: PCT/US2004/030201
- (74) Agents: WHITE, Paul, J. et al.; National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, CO 80401 (US).
- (22) International Filing Date: 16 September 2004 (16.09.2004)
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 60/503,335 16 September 2003 (16.09.2003) US
- (71) Applicant (for all designated States except US): MID-WEST RESEARCH INSTITUTE [US/US]; 425 Volker Boulevard, Kansas City, MO 64110 (US).
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH,

[Continued on next page]

(54) Title: ORGANIC PHOTOVOLTAIC CELLS WITH AN ELECTRIC FIELD INTEGRALLY-FORMED AT THE HETERO-JUNCTION INTERFACE



(57) Abstract: A bi-layer photovoltaic cell, and method (100) of making same, with an electric field applied at the p-n heterojunction interface. The cell includes a first semiconductor layer including a binder, nanocrystals of an n-type semiconductor, and spatially bound cations and a second semiconductor layer contacting the first semiconductor layer that includes a binder, nanocrystals of a p-type semiconductor, and spatially bound anions. The cell further includes a p-n heterojunction at the contacting interface between the first and second semiconductor layers. An electric field is created by the spatially bound cations and anions that are located in the layers proximal to the p-n heterojunction. The nanocrystals are single crystals of organic semiconductors that are less than 50 nanometers in size and that comprise a majority of the volume of their respective layers. The binder is a polymer matrix, such as an epoxy. The cell includes electrical contacts abutting the semiconductor layers.



GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

— of inventorship (Rule 4.17(iv)) for US only

Declarations under Rule 4.17:

- *as to the identity of the inventor (Rule 4.17(i)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE,*

Published:

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.